**3GPP TSG RAN WG2#121 R2-2301953**

**Athens, Greece, February 27th - 3rd March, 2023**

**Source: ZTE Corporation, Sanechips**

**Title: [AT121][104][NR NTN enh] NTN-NTN cell reselection (ZTE)**

**Agenda item:** **8.7.4.1.2**

**Document for:** **Discussion and Decision**

# Introduction

This document is intended address NTN-NTN cell reselection open issues as per the following email discussion guidelines:

* [AT121][104][NR NTN enh] NTN-NTN cell reselection (ZTE)

Initial scope: continue the discussion on trigger for measurements and cell reselection criteria enhancements based on the selected papers above

Initial intended outcome: Summary of the offline discussion with e.g.:

·         List of proposals for agreement (if any)

·         List of proposals that require online discussions

Please note the following deadlines:

* Deadline for companies' feedback:  **Thursday 2023-03-02 22:00 EET**
* Deadline for rapporteur's summary (in R2-2301953): Friday 2023-03-03 08:00 EET

# Discussion

## Trigger for measurements

### Location based trigger

The following agreements have been made at first online of RAN2#121:

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| Agreements:1. In R18, for earth-moving system, satellite with steerable beam is not considered as part of mobility enhancement in NTN.
2. A serving cell reference location and a distance threshold/radius will be broadcast for earth-moving cell. FFS on whether the R17 IEs are reused or not. FFS on whether additional information needs to be broadcast to inform the UE how the reference location moves over time or if this can be derived from other information (e.g. Epoch time and ephemeris).
3. For cell selection/reselection, location-based measurement initiation is supported in earth-moving cell
 |

For earth-moving cells the key issue is how to update or track the movement of serving cell reference location with the movement of satellite. In [1], it explained that for moving cell with fixed beam the serving cell reference location is relatively static to satellite. If satellite’s trajectory can be derived, then the serving cell reference location can be known too. The assumption of NTN is that UE can derive satellite’s trajectory based on the satellite ephemeris and epochTime which means this information can also be used for estimating the trajectory of serving cell reference location associated to the satellite at epochTime. For example, UE is provided with the reference location at epochTime and satellite ephemeris, then UE can derives the angles between the reference location and satellite’s nadir. Because the beam is fixed, the angle remain unchanged with the movement of satellite. Therefore, as long as the satellite’s position is known, UE shall be able to derive the reference location with respect to the satellite.

**Question 1.1) Do companies agree that for earth-moving cell with fixed beam, the trajectory of serving cell reference location can be derived by UE based on satellite’s ephemeris and ephochTime. If not, please elaborate why it is not feasible in the “Comments” row.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments**  |
| Intel | agree |  |
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If above understanding is confirmed, it still needs discussed whether more information other than epochTime and ephemeris (e.g., validity timer) is needed or not. Companies support validity timer indicates it is to avoid frequent SI update caused due to update of reference location.

Rapporteur observes that current NTN ephemeris information will be provided together with ntn-UlSyncValidityDuration, which specifies the time period that the ephemeris is considered as valid. Since UE needs a valid ephemeris information to estimate the movement of reference location, it is straightforward that current can be used to to update reference location if needed, therefore a new timer seems unnecessary. Company are welcome to provide their comments on whether additional assisting information is needed apart from the ones have already known in SIB19.

**Question 1.2) With the above understanding, do companies consider additional information apart from that can be provided in SIB19 (i.e.,ephemeris, epochTime,** **ntn-UlSyncValidityDuration ) is needed for UE to derive the trajectory of reference location? If so, please elaborate which parameters are needed, how they can be used, and why current SIB19 parameters are inadequate.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Intel | yes | If PVT ephemeris is broadcast, multiple reference locations and the corresponding time stamps should be provided by NW. if orbital parameters are broadcast, we agree current single reference location is sufficient. |
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Another ffs issue is whether R17 IEs (i.e., referenceLocation) can be reused to indicate the serving reference location for erth-moving cell. Based on companies’s comments online, the concern on reusing the referenceLocation for earth-moving cell is that UE may not be able to differentiate between a earth-fixed cell and a earth-moving cell. In response to this concern, one possible way is that UE can rely on the presence of t-service to know if it is a quasi-fixed cell or not. Companies are kindly asked to provide their preference and comments if any.

**Question 1.3) Do companies agree to reuse referenceLocation to indicate the serving cell reference location for moving cell? If not, please add your comments in below table.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Intel | no | t-service is still optional, we prefer to define a new parameter for reference location in earth-moving cell |
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Furthermore RAN2 has agreed for cell selection/reselection, location-based measurement initiation is supported in earth-moving cell. Rapporteur understands the intention is to reuse the mechanism for quasi-fixed cell where UE initiates measurements when its location to serving cell reference location is larger than the configured distance threshold. In order to guarantee that companies understanding is on the same page, it is proposed to discuss if for earth-moving cell, the location-based cell measurement rules of quasi-fixed mechanism is reused.

**Question 1.4) Do companies agree for earth-moving cell, the location-based cell measurement rules of quasi-fixed mechanism is reused, i.e., for cell reselection in earth-moving cell, UE initiates measurements when its location to serving cell reference location is larger than the configured distance threshold?**

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| **Company** | **Yes/No** | **Comments** |
| Intel | Yes |  |
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With above understanding, a distance threshold is needed to enable location-based measurement initiation for cell reselection in earth-moving cell. Two options have been proposed to indicate the distance thresh on whether it is proposed to reuse the distanceThresh for the same purpose, while there are proposals to have new IEs to have clear differentiation between earth-moving and quasi-fixed cells.Companies are welcome to provide comments on if distance threshold is needed and provide their preference on whether to reuse distanceThresh or new IE for earth-moving cell.

**Question 1.5) Do companies agree a distance threshold is needed for location-based measurement initiation for cell reselection in moving cells? If so, please indicate your preference on how to indicate this information (e.g., reuse distanceThresh or use new IE). Comments are welcome.**

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| --- | --- | --- | --- |
| **Company** | **Yes/No** | **Reuse distanceThresh or new IE?** | **Comments** |
| Intel | Yes | New IE | Similar to the answer to Q1.3 |
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### Time-based trigger

It is unclear for moving cell, whether time-based measurement initiation is also needed. Based on companies contribution, there are two possible scenarios for time-based measurement initiation:

* Case 1: Stop time due to service link change
* Case 2: Stop time due to feeder-link switch

For case 1: the intention is to introduce a t-service like mechanism as for quasi-fixed system, where the time when satellite is going to stop provides coverage is provided to UE so that it can start measurements for cell reselection before stop time. And this time information is common for all UEs within this coverage and deterministic for quasi-fixed system. However for earth-moving cells, the time the serving cell stops providing service to UE is not the same therefore t-service based measurement may not so meaningful for earth-moving cells.

For case 2, rapporteur understands the feeder-link switch timing is common to all UEs and deterministic, there it is possible to specify a time-based mechanism for this scenaerio.

Companies are encouraged to provide comments on whether time-based initiation measurement is needed for earth-moving cel and what’s the interested scenarios.

 **Question 1.6) Companies are kindly asked to indicate their preference on whether to support time-based measurement initiation for moving cells and the interested scenarios for study as shown below:**

* **Case 1: Stop time due to service link change**
* **Case 2: Stop time due to feeder-link switch**
* **Others, if any**

**Comments are welcome.**

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| --- | --- | --- | --- |
| **Company** | **Support /Not support** | **case 1 or case 2 or both or..** | **Comments** |
| Intel | Not support |  | We understanding in earth-moving cell, the distance based trigger is actually coverage based trigger. And time based trigger is just another condition that also relies on coverge prediction. |
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## Cell reselection criteria

Location-based cell reselection and time -based cell reselection have discussed in R17 but not concludes. Location-based cell reselection criteria is proposed to limit the number of candidate cells to be considered for cell reselection while time-based measurement initiation can help UE to reselect to serving cell with longer serving time so that cell reselection frequencies is reduced. Both is helpful for power consumption reduction, which is also one of the cell reselection enhancement purpose. Based on the proposals, companies are kindly asked to provide comments on whether to support location-base cell reselection criteria and /or time-based cell reselection criteria.

**Question 2.1) Companies are kindly asked to indicate their preference on whether to support time-based location-base cell reselection criteria and /or time-based cell reselection criteria for NTN-NTN cell reselection. Comments are welcome.**

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| --- | --- | --- | --- |
| **Company** | **Support location-based** **(Yes or No)** | **Support time-based****(Yes or No)** | **Comments** |
| Intel | Yes | No | Similar comments as in Q1.6 |
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Companies supporting to specify location and/or time-based cell reselection criteria for NTN-NTN cell reselection are invited to provide comments to subsequent questions on the discussion on detailed solutions.

 For location based solution, the following options have been identified in R17 for further study.

* **Option 1: Introduce a distance threshold. Cell ranked on R-criterion first and then the distance threshold applies to down scope the candidate cells for reselection.**

- Step 1: UE perform cell ranking based on the R-criterion.

- Step 2: Among the highest ranked N cells:

- For cells provided with reference location: only those whose distance to UE shorter than the distance threshold will be considered by UE as candidate cells.

- For cells not provided with reference location:

Alt.1: Not considered as candidate cell for reselection

Alt.2: Considered as candidate cell for reselection

- Step 3: Among all the candidate cells decided by on the distance threshold in step 2, UE reselect to the highest ranked cell based on R-criterion.

* **Option 2: Introduce a distance threshold. Distance threshold applies to decide the candidate cells and then rank the candidate cells based on R-criterion to decide the target cell for reselection.**

- Step 1:

- For cells provided with reference location: UE evaluate the distance to neighbour cell reference location and only consider cells whose distance to UE are shorter than the threshold to be candidate cells for cell ranking;

- For cells not provided with reference location:

Alt.1: Not considered as candidate cell for reselection

Alt.2: Considered as candidate cell for reselection

- Step 2: UE perform cell ranking on candidate cells decided in step 1 according to R-criterion.

- Step 3: UE reselect to the highest ranked cell.

* **Option 3: Cell ranked on R-criterion first and then the distance criteria applies to decide the target cell for reselection.**

- Step 1: UE perform cell ranking based on the R-criterion.

- Step 2: Among the highest ranked N cells:

- For cells provided with reference location, UE reselect to the cell with the smallest distance to the cell’s reference location.

- For cells not provided with reference location, UE reselect to the highest ranked cell based on R-criterion.

Companies supporting location based solution are invited to provide comments on below

**Question 2.2) Which option do companies prefer to adopt for location based cell reselection in NTN? If option 1/2 is selected, please further indicate which alternative is preferred on the handling of cells not provided reference location.**

* **Option 1: Introduce a distance threshold. Cell ranked on R-criterion first and then the distance threshold applies to down scope the candidate cells for reselection.**
	+ **For cells not provided with reference location:**
		- **Alt.1: Not considered as candidate cell for reselection**
		- **Alt.2: Considered as candidate cell for reselection**
* **Option 2: Introduce a distance threshold. Distance threshold applies to decide the candidate cells and then rank the candidate cells based on R-criterion to decide the target cell for reselection.**
	+ **For cells not provided with reference location:**
		- **Alt.1: Not considered as candidate cell for reselection**
		- **Alt.2: Considered as candidate cell for reselection**
* **Option 3: Cell ranked on R-criterion first and then the distance criteria applies to decide the target cell for reselection.**

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| **Company** | **Option 1/2/3/other** | **Alternative 1/2 if option 1/2 is selected**  | **Comments** |
| Intel | Option 2 | Alt.2 | Distance threshold can be used to rule out some candidate cells to save UE power on measurements. |
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For time-based solutions it is proposed that UE shall consider neighboring cell’s serving time into account when performing cell reselection. And below options have been proposed:

* Opt-1) Filtering neighbor cell with RST.
Step-1. UE calculates RST of neighbor cells.
Step-2. UE treats a neighbor cell as barred if RST of neighbor cell is shorter than time threshold.
Step-3. UE performs R-value-based ranking evaluation to neighbor cells.
Step-4. UE performs cell reselection to the highest ranked cell.
* Opt-2) Filtering neighbor cell with R-value.
Step-1. UE performs R-value-based ranking evaluation to neighbor cells.
Step-2. UE treats a neighbor cell as barred if R-value of neighbor cell is less than threshold.
Step-3. UE performs cell reselection to neighbor cell having the longest RST.
* Opt-3) Introduce RST-based R-value offset, in which neighbor cell having longer RST gets bigger value of R-value offset.
Step-1. UE calculates RST of neighbor cells.
Step-2. UE performs R-value-based ranking evaluation to neighbor cells.
Step-3. UE derives new R-value by adding RST-based R-value offset to R-value derived in Step-2.
Step-4. UE performs cell reselection to highest ranked cell.

Companies supporting time based solution are invited to provide comments on below questions

**Question 2.3) Which option do companies prefer to adopt for time based cell reselection in NTN-NTN cell reselection?**

* **Opt-1) Filtering neighbor cell with RST.**
* **Opt-2) Filtering neighbor cell with R-value.**
* **Opt-3) Introduce RST-based R-value offset, in which neighbor cell having longer RST gets bigger value of R-value offset.**

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| **Company** | **Option 1/2/3/other** | **Comments** |
| Intel | none | If reference location and distance threshold are provided for neighbour cells, the distance based neighbour cell selection can also be applied. So we don’t need to introduce another concept of RST. |
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# Conclusions

<To be generated based on company input>

# References

1. [R2-2301142](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2301142%20Consideration%20on%20cell%20reselection%20enhancements%20for%20NTN-NTN.docx) Consideration on cell reselection enhancements for NTN-NTN ZTE Corporation, Sanechips discussion Rel-18

1. [R2-2300344](file:///C%3A%5C%5CData%5C%5C3GPP%5C%5CExtracts%5C%5CR2-2300344%20Discussion%20on%20cell%20reselection%20enhancements%20for%20earth-moving%20cell.docx%22%20%5Co%20%22C%3AData3GPPExtractsR2-2300344%20Discussion%20on%20cell%20reselection%20enhancements%20for%20earth-moving%20cell.docx) Discussion on cell reselection enhancements for earth-moving cell vivo discussion
2. [R2-2300799](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2300799%20Discussion%20on%20NTN-NTN%20cell%20reselection%20enhancements.docx) Discussion on NTN-NTN cell reselection enhancement LG Electronics France discussion Rel-18 NR\_NTN\_enh
3. [R2-2301226](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2301226%20Discussion%20on%20NTN-NTN%20reselection.docx) Discussion on NTN-NTN reselection CMCC discussion Rel-18 NR\_NTN\_enh-Core
4. [R2-2301364](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2301364%20%28R18%20NR%20NTN%20WI%20AI%208.7.4.1.2%29%20Earth%20moving%20cell.docx) Cell reselection enhancements for Earth moving cell InterDigital discussion Rel-18 NR\_NTN\_enh-Core

# Annex: ASN.1 of SIB19

– *SIB19*

*SIB19* contains satellite assistance information for NTN access.

***SIB19* information element**

-- ASN1START

-- TAG-SIB19-START

SIB19-r17 ::= SEQUENCE {

 ntn-Config-r17 NTN-Config-r17 OPTIONAL, -- Need R

 t-Service-r17 INTEGER (0..549755813887) OPTIONAL, -- Need R

 referenceLocation-r17 ReferenceLocation-r17 OPTIONAL, -- Need R

 distanceThresh-r17 INTEGER(0..65525) OPTIONAL, -- Need R

 ntn-NeighCellConfigList-r17 NTN-NeighCellConfigList-r17 OPTIONAL, -- Need R

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 ...,

 [[

 ntn-NeighCellConfigListExt-v1720 NTN-NeighCellConfigList-r17 OPTIONAL -- Need R

 ]]

}

NTN-NeighCellConfigList-r17 ::= SEQUENCE (SIZE(1..maxCellNTN-r17)) OF NTN-NeighCellConfig-r17

NTN-NeighCellConfig-r17 ::= SEQUENCE {

 ntn-Config-r17 NTN-Config-r17 OPTIONAL, -- Need R

 carrierFreq-r17 ARFCN-ValueNR OPTIONAL, -- Need R

 physCellId-r17 PhysCellId OPTIONAL -- Need R

}

-- TAG-SIB19-STOP

-- ASN1STOP

| ***SIB19* field descriptions** |
| --- |
| ***distanceThresh***Distance from the serving cell reference location and is used in location-based measurement initiation in RRC\_IDLE and RRC\_INACTIVE, as defined in TS 38.304 [20]. Each step represents 50m. |
| ***ntn-Config***Provides parameters needed for the UE to access NR via NTN access such as Ephemeris data, common TA parameters, k\_offset, validity duration for UL sync information and epoch. |
| ***ntn-NeighCellConfigList, ntn-NeighCellConfigListExt***Provides a list of NTN neighbour cells including their *ntn-Config*, carrier frequency and *PhysCellId*. This set includes all elements of *ntn-NeighCellConfigList* and all elements of *ntn-NeighCellConfigListExt*. If *ntn-Config* is absent for an entry in *ntn-NeighCellConfigListExt*, the *ntn-Config* provided in the entry at the same position in *ntn-NeighCellConfigList* applies. |
| ***referenceLocation***Reference location of the serving cell provided via NTN quasi-Earth fixed system and is used in location-based measurement initiation in RRC\_IDLE and RRC\_INACTIVE, as defined in TS 38.304 [20]. |
| ***t-Service***Indicates the time information on when a cell provided via NTN quasi-Earth fixed system is going to stop serving the area it is currently covering. The field indicates a time in multiples of 10 ms after 00:00:00 on Gregorian calendar date 1 January, 1900 (midnight between Sunday, December 31, 1899 and Monday, January 1, 1900). The exact stop time is between the time indicated by the value of this field minus 1 and the time indicated by the value of this field. |

#### – *NTN-Config*

The IE *NTN-Config* provides parameters needed for the UE to access NR via NTN access.

*NTN-Config* information element

-- ASN1START

-- TAG-NTN-CONFIG-START

NTN-Config-r17 ::= SEQUENCE {

 epochTime-r17 EpochTime-r17 OPTIONAL, -- Need R

 ntn-UlSyncValidityDuration-r17 ENUMERATED{ s5, s10, s15, s20, s25, s30, s35,

 s40, s45, s50, s55, s60, s120, s180, s240, s900} OPTIONAL, -- Cond SIB19

 cellSpecificKoffset-r17 INTEGER(1..1023) OPTIONAL, -- Need R

 kmac-r17 INTEGER(1..512) OPTIONAL, -- Need R

 ta-Info-r17 TA-Info-r17 OPTIONAL, -- Need R

 ntn-PolarizationDL-r17 ENUMERATED {rhcp,lhcp,linear} OPTIONAL, -- Need R

 ntn-PolarizationUL-r17 ENUMERATED {rhcp,lhcp,linear} OPTIONAL, -- Need R

 ephemerisInfo-r17 EphemerisInfo-r17 OPTIONAL, -- Need R

 ta-Report-r17 ENUMERATED {enabled} OPTIONAL, -- Need R

 ...

}

EpochTime-r17 ::= SEQUENCE {

 sfn-r17 INTEGER(0..1023),

 subFrameNR-r17 INTEGER(0..9)

}

TA-Info-r17 ::= SEQUENCE {

 ta-Common-r17 INTEGER(0..66485757),

 ta-CommonDrift-r17 INTEGER(-257303..257303) OPTIONAL, -- Need R

 ta-CommonDriftVariant-r17 INTEGER(0..28949) OPTIONAL -- Need R

}

-- TAG-NTN-CONFIG-STOP

-- ASN1STOP

|  |
| --- |
| *NTN-Config* field descriptions |
| ***EphemerisInfo***This field provides satellite ephemeris either in format of position and velocity state vector or in format of orbital parameters. This field is excluded when determining changes in system information, i.e. changes to ephemerisInfo should neither result in system information change notifications nor in a modification of *valueTag* in *SIB1*. |
| ***epochTime***Indicate the epoch time for the NTN assistance information. When explicitly provided through SIB, or through dedicated signaling, the *EpochTime* is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signaled together with the assistance information. For serving cell, the field *sfn* indicates the current SFN or the next upcoming SFN after the frame where the message indicating the *epochTime* is received. For neighbour cell, the *sfn* indicates the SFN nearest to the frame where the message indicating the *epochTime* is received. The reference point for epoch time of the serving NTN payload ephemeris and Common TA parameters is the uplink time synchronization reference point. If this field is absent, the epoch time is the end of SI window where this SIB19 is scheduled. This field is mandatory present when provided in dedicated configuration. If this field is absent in *ntn-Config* provided via *NTN-NeighCellConfig* the UE uses epoch time of the serving cell, otherwise the field is based on the timing of the serving cell, i.e. the SFN and sub-frame number indicated in this field refers to the SFN and sub-frame of the serving cell. In case of handover or conditional handover, this field is based on the timing of the target cell, i.e. the SFN and sub-frame number indicated in this field refers to the SFN and sub-frame of the target cell. For the target cell the UE considers epoch time, indicated by the SFN and sub-frame number in this field, to be the frame nearest to the frame in which the message indicating the epoch time is received. This field is excluded when determining changes in system information, i.e. changes to *epochTime* should neither result in system information change notifications nor in a modification of *valueTag* in *SIB1*. |
| ***cellSpecificKoffset***Scheduling offset used for the timing relationships that are modified for NTN (see TS 38.213 [13]). The unit of the field K\_offset is number of slots for a given subcarrier spacing of 15 kHz. If the field is absent UE assumes value 0. |
| ***kmac***Scheduling offset provided by network if downlink and uplink frame timing are not aligned at gNB. It is needed for UE action and assumption on downlink configuration indicated by a MAC CE command in PDSCH (see TS 38.213 [13]). If the field is absent UE assumes value 0.For the reference subcarrier spacing value for the unit of K\_mac in FR1, a value of 15 kHz is used. The unit of K\_mac is number of slots for a given subcarrier spacing. |
| ***ntn-PolarizationDL***If present, this parameter indicates polarization information for downlink transmission on service link: including Right hand, Left hand circular polarizations (RHCP, LHCP) and Linear polarization. |
| ***ntn-PolarizationUL***If present, this parameter indicates Polarization information for uplink service link.If not present and ntn-PolarizationDL is present, UE assumes the same polarization for UL and DL. |
| ***ntn-UlSyncValidityDuration***A validity duration configured by the network for assistance information (i.e. Serving and/or neighbour satellite ephemeris and Common TA parameters) which indicates the maximum time duration (from *epochTime*) during which the UE can apply assistance information without having acquired new assistance information.The unit of *ntn-UlSyncValidityDuration* is second. Value *s5* corresponds to 5 s, value *s10* indicate 10 s and so on. This parameter applies to both connected and idle mode UEs. If this field is absent in *ntn-Config* provided via *NTN-NeighCellConfig,* the UE uses validity duration from the serving cell assistance information. This field is excluded when determining changes in system information, i.e. changes of *ntn-UlSyncValidityDuration* should neither result in system information change notifications nor in a modification of *valueTag* in *SIB1*. *ntn-UlSyncValidityDuration* is only updated when at least one of *epochTime*, *ta-Info*, *ephemerisInfo* is updated. |